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Journal of the Proceedings of the Royal Society of London

A N
ACCOUNT OF A METHOD
O F
PRESERVING WATER,
A T S E A, &c.

A N

ACCOUNT OF A METHOD OF
PRESERVING WATER, AT SEA,

F R O M

P U T R E F A C T I O N,

A N D O F

RESTORING TO THE WATER

ITS ORIGINAL PLEASANTNESS AND PURITY,

BY A CHEAP AND EASY PROCESS:

TO WHICH IS ADDED

A MODE OF IMPREGNATING WATER,

IN LARGE QUANTITIES,

WITH FIXED AIR,

For MEDICINAL USES, on BOARD SHIPS, and in HOSPITALS;

AND LIKEWISE

A PROCESS FOR THE PREPARATION OF

ARTIFICIAL YEAST.

By THOMAS HENRY, F. R. S.

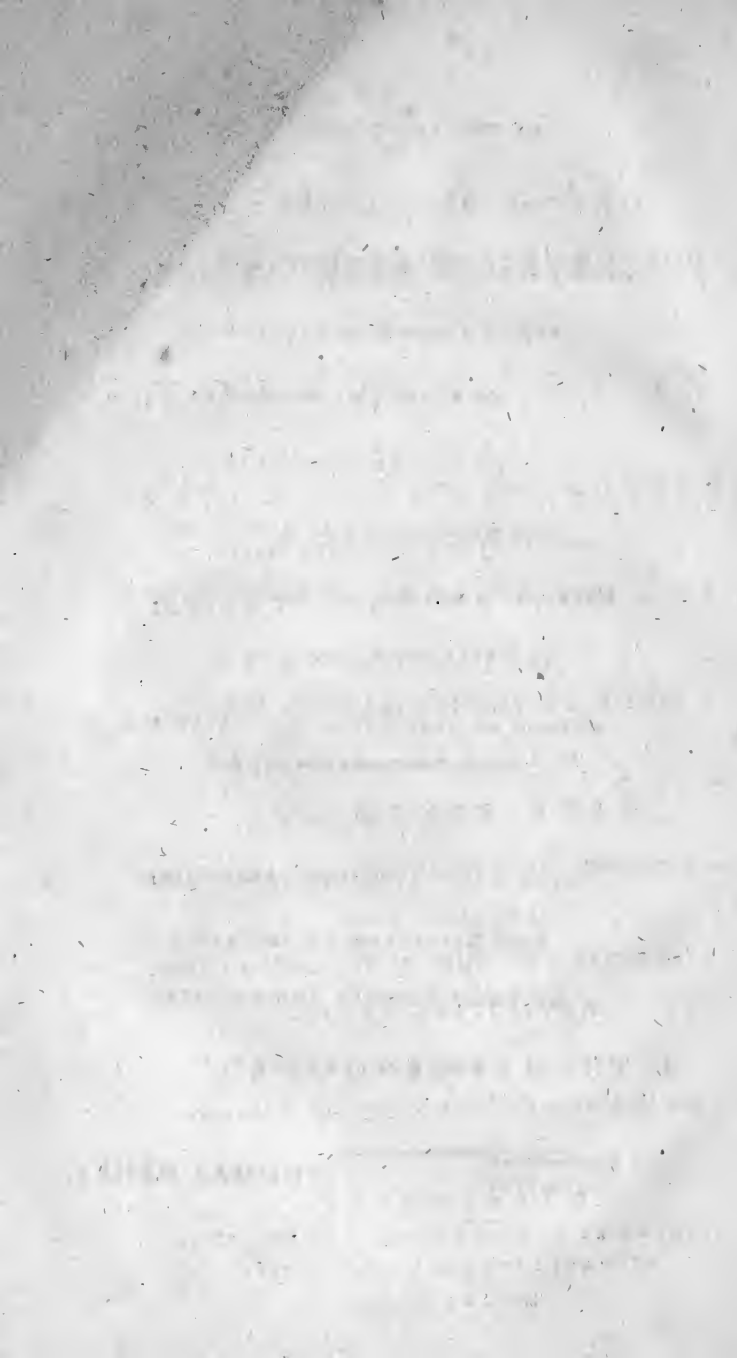
And MEMBER of the MEDICAL SOCIETY of LONDON.

W A R R I N G T O N :

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M D C C L X X I.



TO THE RIGHT HONOURABLE

J O H N

EARL OF SANDWICH, &c.

FIRST LORD COMMISSIONER,

AND TO THE OTHER

LORDS COMMISSIONERS

FOR EXECUTING THE OFFICE OF

LORD HIGH ADMIRAL OF GREAT BRITAIN,

THE FOLLOWING ACCOUNT OF A

METHOD OF PRESERVING WATER, AT SEA,
FROM PUTREFACTION, &c.

I S,

WITH THEIR LORDSHIPS' PERMISSION,

MOST RESPECTFULLY INSCRIBED

BY THEIR DEVOTED AND OBEDIENT

HUMBLE SERVANT,

MANCHESTER,
May 24, 1781.

THOMAS HENRY.

TO THE HONORABLE THE SECRETARY OF THE

H O U S E

OF REPRESENTATIVES

WASHINGTON, D. C.

DEAR MR. SECRETARY:

I have the honor to acknowledge

the receipt of your letter of the 10th inst.

in relation to the proposed amendment to the
constitution of the United States, which provides
that the President shall be elected for a term of
four years, and that he shall be eligible for
re-election only once. I am very glad to hear
that you are so interested in this important
question, and I am sure that your views will
be given due consideration. I am, Sir,
Very respectfully,
Your obedient servant,
J. M. Smith

J. M. Smith, Secretary of the House of Representatives
Washington, D. C.

P R E F A C E.

THE Author of the following Account is by no means ignorant of the advantages which may be derived from the mode of distilling Sea-Water, which has been lately invented ; but he apprehends it is intended only to furnish a partial supply of fresh water, in cases of necessity, and insufficient for the consumption of a large crew : whereas his scheme aims at the constant preservation of water, from the putrefaction to which it is exposed in long voyages. The same process, also, which is directed for the precipitation of the lime, may, with a smaller

vi. P R E F A C E.

smaller portion of the effervescing substances, be commodiously used for the speedy restoration of the air of which water is deprived by distillation; and thus the objections which have been made to the want of spirit and supposed insalubrity of distilled water will be effectually removed, whenever the consumption of a ship's store of water shall render it necessary to have recourse to distillation.

E R R A T U M.

Page 26, line 19, *for remained read remains.*

AN ACCOUNT OF A METHOD OF
PRESERVING WATER
ON
SHIP-BOARD
FROM
PUTREFACTION, &c.

THAT the strength, safety and wealth of this nation depend principally on her Marine, is a fact, the truth of which has been long established. The preservation, therefore, of the health and lives of our Seamen should always have been considered as a primary object of attention, by Government.

Yet notwithstanding the ravages made by that destructive disease, the sea-scurvy, among
B this

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this valuable body of men, so little had been done towards the prevention of the evil, that even at so late a period as that of the late Lord Anson's circumnavigation, the *Centurion*, the Commodore's ship, before she had reached the island of Juan Fernandes, had buried two hundred of her crew, and could muster no greater a number than six of the common sailors in a watch, who were capable of doing duty. The other two ships which arrived at that island, had suffered in proportion.

The remaining part of the crews of the three ships, having, by means of fresh air and vegetable diet, during their continuance on the island, recovered from the scurvy, embarked on board the *Centurion*; but before the ship arrived at Tinian the sickness returned, and, at the expiration of the second year, so great had been the mortality, that, horrid to relate! the historian of the voyage informs us, more than four fifths of the original number of these brave, these useful members of society had fallen victims to the scurvy or putrid fevers.

How

How great the contrast between this melancholy description, and the pleasing narrative which the ever to be lamented captain Cook has given of a voyage equally long in its duration, and more variable in climate. In this voyage, in which he passed through all the climates from 52 deg. N. to 71 S. with a company of one hundred and eighteen men, and the performance of which employed no less a period than three years and eighteen days, this prudent, this humane Commander lost only one man by disease; and it even appears that this man carried on board with him the primary symptoms of the disorder which, afterwards, destroyed him.

Much praise is due to Government for the many salutary arrangements made on board the vessels sent on that expedition, previous to their sailing; and great was the merit of the excellent Commander of the Resolution, in the unremitting attention paid by him to the use of every thing that could contribute, and the avoiding of every thing injurious, to the health and preservation of his men. Justly did the Royal Society decree to him the

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honourable reward of their annual medal, and most justly are his merits celebrated in the eloquent oration, delivered on that occasion, by the late learned and worthy president, Sir John Pringle.

In the voyage which captain Cook performed, with such extraordinary success, he was particularly fortunate in meeting with frequent supplies of fresh water.* The islands in the South Sea, at which he stopped, abounded with springs of excellent water; and when, in the high southern latitudes, after a long absence from land, he was in danger of a scarcity of that article, the mountains of ice unexpectedly furnished him with an ample quantity of it; the salt having been precipitated from the sea water by the act of freezing—a circumstance which though it had been, in general, either unattended to, or

* “I never failed to take in water wherever it was to be procured, even when we did not seem to want it; because I look upon fresh water from the shore to be much more wholesome than that which has been kept some time on board.”

Captain Cook's Method for preserving the Health of Seamen.
Phil. Transf. vol. LXVI. p. 405.

contro-

controverted, has been amply confirmed by experiment.*

If this had not been the case, and had the crew of the Resolution been under the necessity of drinking water in that putrid state to which it is too frequently reduced in long voyages, it is to be feared that all the other precautions would have fallen short of the success that attended them. The sea-scurvy is allowed on all hands, to be a putrid disease, and to be the consequence of putrid air, putrid provisions, putrid water, and the deficiencies of vegetable diet and cleanliness.

The drinking of putrid water is not only highly disagreeable and disgusting, but extremely noxious to the constitution. Every kind of putrid matter received into the body acts as a ferment, and spreads its influence through the animal system. Were the former the only inconvenience experienced by the gallant defenders of our island, the gratitude

* Mr Nairne's Experiments on Water obtained from the melted ice of sea water.

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we owe them, should make us anxious to remove it : but when we see these brave men languishing from the want of fresh and wholesome water ;* when we see diseases undermining those constitutions which nature had formed to last to a good old age ; when we behold those lives, so valuable to their country, prematurely destroyed by the same deleterious cause, what zeal can be too ardent, what endeavours too active to remove the evil !

A method of preserving water free from putrefaction was some years since proposed by the late Dr. Alston. It consisted in adding a quantity of lime to every cask of water. That substance is known to have a strong antiseptic property ; and water, as long as it retains the impregnation of lime, never putrefies. But the lime communicates a disagreeable taste to the water, and, abstracted from that

* “ I am convinced, that with plenty of fresh water, and a close attention to cleanliness, a ship's company will seldom be much afflicted with the scurvy, though they should not be provided with any of the antiscorbutics before-mentioned.”

Phil. Transf. vol. LXVI. p. 403.

inconvenience, might, perhaps, in many instances, be detrimental.

To free the water, at the time of using it, from the lime, Dr. Alston proposed the precipitation of the latter, by throwing into the water a quantity of magnesia alba; on this principle; that as lime-stone is rendered soluble in water by its deprivation of fixed air, and has a greater affinity with that air than magnesia has, the particles of quick-lime dissolved in the water would attract the air from the magnesia, and thereby becoming no longer soluble, would fall to the bottom, and leave the water tasteless and fit for œconomical uses.

Dr. Alston's theory was just; but the expence attending it, owing to the price of magnesia was such (though the expence should be great indeed which is to be placed in the balance against the preservation of our mariners) as to prevent the execution of the proposal.

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My attention was directed some time since to this subject, by the trouble I had often experienced from the water in the tub, intended to cool the worm of my still, becoming putrid, if not frequently emptied; and the labour of filling it with fresh water was irksome to my servant from the distance he had to carry it. The putrefaction of it was accelerated by the necessity of the tub being placed within a very small distance of a continual fire which is kept in my laboratory, and the fetor of the putrid water was exceedingly offensive. It occurred to me that the addition of lime to the fresh water might obviate the inconvenience. The event has far exceeded my most sanguine expectations; for the water, though very repeatedly exposed to the heat raised in distillation, added to the warm situation in which it was placed, continued free from the least degree of putrefaction above eighteen months, and was then thrown away, only because it was become foul from dust. The water, wasted by evaporation, was supplied from time to time by fresh quantities, but the original water was never removed during that period,

period,* and it was constantly exposed to the action of the atmospherical air.

So strong a proof of the antiseptic influence of lime on water impressed me forcibly. Dr. Alston's scheme recurred to my mind, and it appeared very desirable to invent some method of rendering it more applicable to the purposes of the navy. This would be accomplished, if a cheap and easily practicable method could be discovered of precipitating the lime, and thereby restoring the water to its original taste.

In order to produce this effect, I have made a variety of experiments; with the relation of which I shall not detain the reader; but shall proceed to describe the method of impregnating the water with lime, and also the means of precipitating the lime from the water, at the time of its use, and restoring its original sweetness and pleasantness; after which I shall give an account of an easy method of impregnating water, *in large quantities*, with

* This method would prevent much labour in large distilleries.

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fixed air, for the use of the sick on board his Majesty's and other ships, as well as for hospital practice.

The Method of impregnating the Water with Quick-Lime.

To every cask of water of 120 gallons, add * two pounds of well burnt quick-lime, either fresh from the kiln, or preserved, as directed in a subsequent part of this Treatise. When the lime has been in the cask some minutes, and the heat and effervescence occasioned by the mixture are over, let the cask be carefully stopped from any communication with the external air.

* In the directions lately published, by order of the French government, for preserving the health of their Seamen, which are inserted in the third number of the Medical Commentaries for 1780, they have adopted the practice of adding quick-lime, in the proportion of one pound to every whole cask, and half a pound to each half cask of water. Had they been acquainted with a method of again freeing the water from the lime, they would, doubtless, have prescribed a larger proportion of the latter; for they acknowledge that quantity to be insufficient to preserve the water free from putrefaction: to correct which, they direct a quantity of vinegar to be added at the time the water is drawn off for use.

The

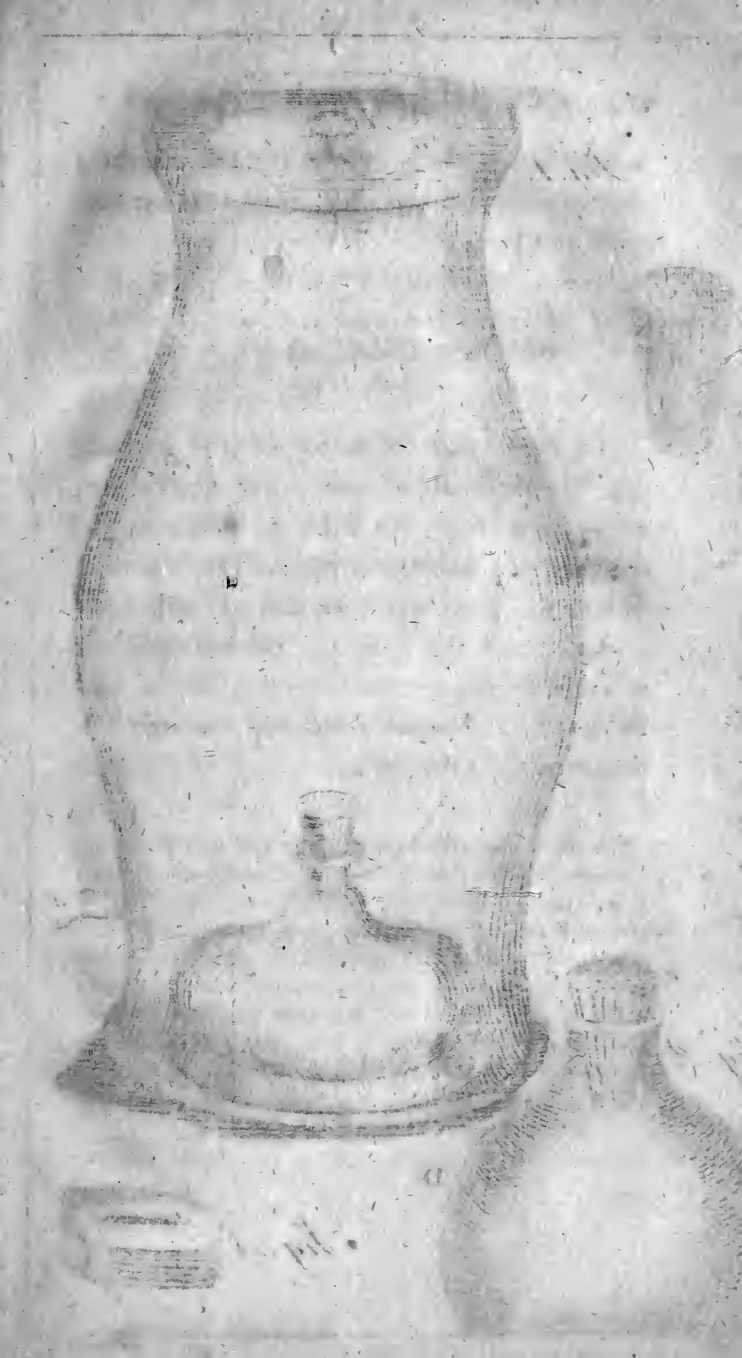


Fig. 1.

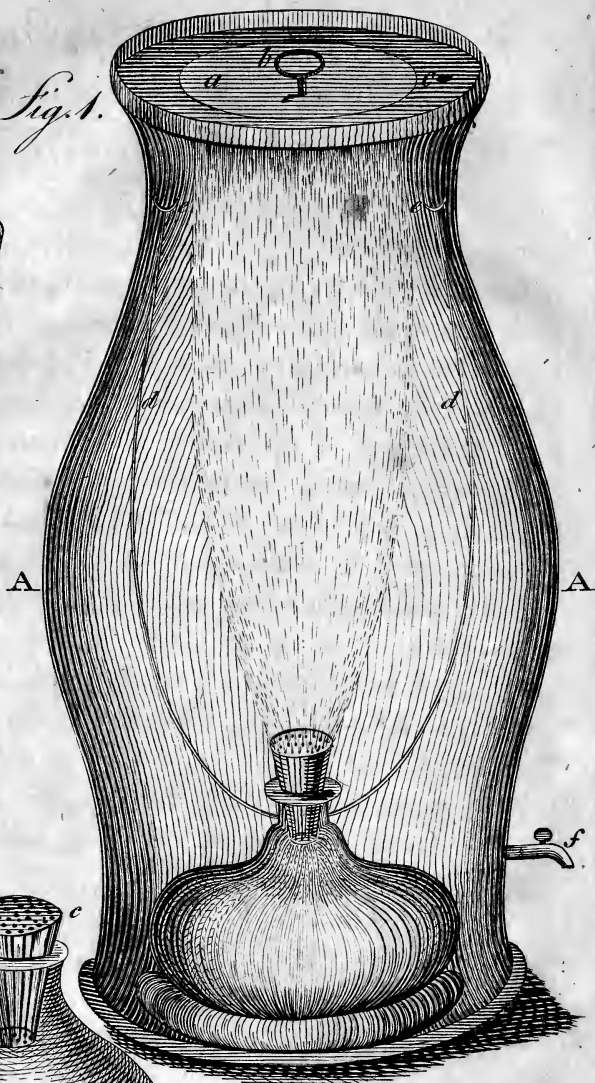


Fig. 3.



Fig. 2.



Fig. 4.



*The Method of freeing the Water from the Lime,
and restoring it to its former State.*

Let a cask, (AA, fig. 1.) be prepared, of a form something narrower in its diameter in proportion to its depth than usual. The top, (*a*) must be formed of one plank, and have a piece cut out of the centre, of a circular form, and as large as can be allowed without weakening the sides too much.* This piece, or bung, must be made to fit as closely as possible, and have an iron handle (*b*) affixed to it, for the purpose of lifting it, and of confining a weight (fig. 4.) which is to be laid on, to keep the bung from yielding to a small force from within. A small hole (*c*) must be bored in the side of the top, which is to be exactly stopped with a plug, for a purpose to be explained in the sequel.

* If these sides be made of strong timber, closely cemented, they may be sufficiently firm; and the bung may be formed of a thicker plank, and turned in a lathe so as to fit very closely.

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Fill this cask, which may be supposed to contain sixty gallons, secured on a convenient part of the deck, or slung up in the shrouds, with the lime-water, drawn off clear from the sediment, so as to avoid any visible particles of lime floating in it; allowing sufficient room for the air vessel, and a free space of about half an inch between the surface of the water and the top of the cask.

Let a vessel (DD, fig. 2.) be also prepared, capable of containing two gallons, or $\frac{1}{30}$ of the capacity of the cask (AA, fig. 1.) Into this vessel introduce half a pound of marble, pure *unburnt* lime-stone or chalk* grossly powdered, and two quarts of water. Then pour gradually on these, three ounces of strong vitriolic acid, commonly called oil of vitriol, and stopping the mouth of the vessel (DD) with the tubulated stopper (cc) let it down by means of the strings (dd) into the cask†

* I shall, in future, make use of the term *mild calcareous earth* as including all these species of it; and of these the preference is to be given in the order in which they are placed in the text.

† These strings are to be fastened to the pegs (ee) when the air vessel is let down.

which

which is drawn transparent, to shew the state of the whole apparatus. The fixed air, let loose from the mild calcareous earth, will bubble up through the lime-water. When this has continued about a minute, the bung (*a*) is to be fastened on, and the weight (C, fig. 4.) slipped over the ring of the handle (*b*) to keep the bung in its place. In about an hour the bung may be removed, in order to see whether the discharge of air continues. If it have ceased, or be considerably abated, three ounces more of vitriolic acid is to be added, and the air vessel returned to its former station in the cask.

The time necessary to precipitate the lime from the water will be in proportion to the briskness of the effervescence, but in general a few hours will be sufficient. Should the first parcel of calcareous earth and vitriolic acid be unequal to the sweetening of the lime-water, and no longer discharge air briskly when agitated; the contents of the air vessel are to be poured out, and a fresh quantity of the ingredients substituted in their place.

When

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When the water is become quite mild, the air vessel is to be taken out, and, if the calcareous earth continue to discharge air, be plunged into another cask of lime-water, that there may be no needless expence of the fixed air.

The specific gravity of the lime is so much superior to that of the water, that it will soon fall to the bottom of the cask when the operation is finished. As soon as the water is become clear, it must be drawn off by the cock (*f*) for use; or, if the cask be wanted to purify other quantities of water, it may be drawn off sooner into other vessels to clarify.

The precipitated lime may be collected and dried, and, being now in the state of chalk, and impalpably powdered, may be used instead of prepared chalk for the medicinal purposes to which that article is applied.

Cautions to be observed in the above Processes.

1. The quick-lime should be chosen as pure, free from any foreign taste, white, well
burnt

burnt and fresh from the kiln as can be obtained. What is carried to sea for future use, should be carefully packed up in clean tight casks, so as to preserve it from moisture and the action of the air.

2. The casks, into which the lime-water is put, should be perfectly clean and sweet; and those should be selected for this use that are well seasoned and free from sap.

3. The water is to be first poured into the air vessel (DD;) then the calcareous earth, which is to pass through a paper cone to prevent its adhering to the sides of the mouth of the vessel; and lastly, the acid is to be added, no attention being paid to the mixing the earth and water intimately. By this means the acid attacks the calcareous earth gradually, and the vessel is in no danger of bursting by the too sudden explosion of the air. For the same reason, care should also be taken that the air vessel be not shaken too rapidly.

4. Gently

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4. Gently agitating the upper part of the cask from time to time, during the process, will accelerate the completion of it, by occasioning a quicker absorption of the fixed air. And the small plug must occasionally be taken from the orifice (c) to let out the part of the air which is not soluble in water.

5. The precipitated lime is to be cleared out of the cask (AA) after each time of using it; and the cask should be frequently washed out thoroughly.

6. Care must be taken that the mouth of the air vessel be clear of calcareous earth before the stopper be put in; and that the ends of the tubes in the stopper be not clogged up with any thing that may prevent the passage of the air through them.

7. Each ship should be provided with several of the air vessels, and each vessel should have two or three tubulated stoppers adapted to it. The vessels and their stoppers to be marked with similar numbers.

8. The

8. The size and number of the purifying casks must be proportioned to the rate of the ship, and the convenience with which they can be managed.

9. If the cask be left with the air vessel in it during the night, or for any considerable length of time, a smaller plug may be put into the small hole (*c*) in the top of the cask, so as to leave it not quite air tight.

10. If during the process, the fixed air should escape, by the edges of the round bung, it may be prevented by any slight luting, which may be easily removed when the bung is to be taken out.*

11. It will be scarcely necessary to mention that the air vessel and the large circular bung-hole, in the top of the cask, are to be so proportioned, that the latter will easily admit of the passage of the former through its aperture.

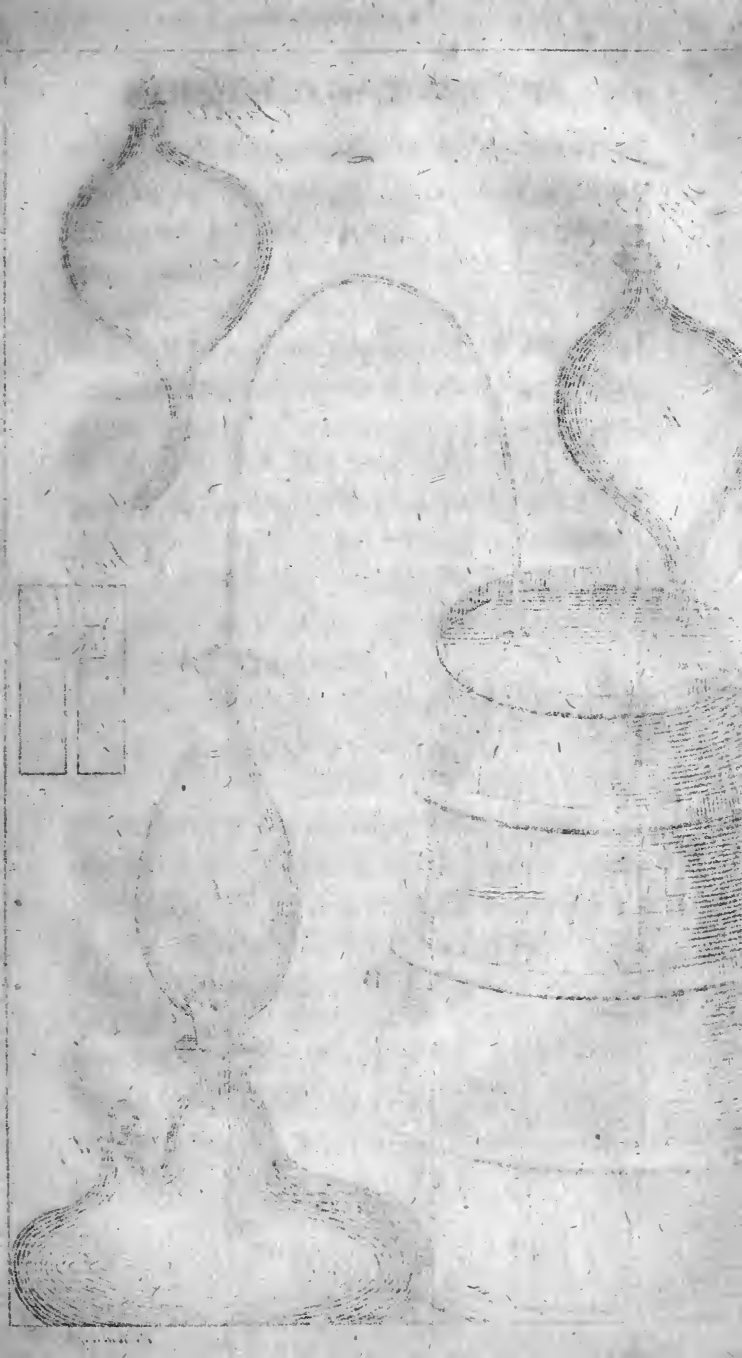
* The escape of air will prolong, but not wholly prevent the success of, the process.

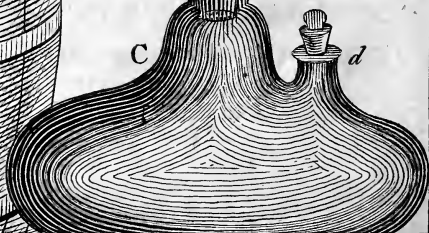
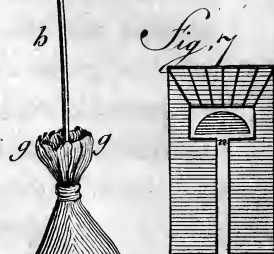
The Method of impregnating Water in large Quantities with Fixed Air, so as to give it the Properties of Mineral Water, for the Use of the Sick on Board of Ships, and in Hospitals.

DR. PRIESTLEY, some years ago, communicated to the Lords of the Admiralty a method of impregnating water with fixed air, obtained from an effervescing mixture of chalk and vitriolic acid, and of making an artificial Pyrmont water. This operation has since been considerably facilitated by the invention of Dr. Nooth's glass machine, with Mr. Parker's and Mr. Magellan's improvements.

That machine, though admirably contrived for the preparation of such quantities of artificial mineral water as may be necessary in private families, would be too small for the sickly crew of a large ship. But it appears to me that a mode may be adopted by which the process may be performed on a much larger scale.

The





The advantages which would proceed from an easily practicable method of supplying the sick men in long voyages with such water, must be obvious to every medical practitioner. The mineral waters of Pyrmont and Seltzer may, by these means, be closely imitated, and the artificial water will be beneficial in all cases in which the natural is found useful. By this process also may Mr. Bewley's mephitetic julep be prepared; than which the materia medica, perhaps, does not afford a more efficacious or more grateful medicine in putrid fevers, scurvy, dysentery, bilious vomitings, hectic, &c.

THE PROCESS.

Cut off the two extremities of a calf's or pig's bladder (*f*) (fig. 5.) and having previously moistened them, into one end insert the top of the tubular stopper (*e*) round the neck of which it is to be closely fastened with strong thread. Into the upper end introduce the part (*g*) of the long bent tube (*b*) and tie them round in the same manner. The pipe (*b*) must be passed through a hole,

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formed by a hot iron borer, in a large cork adapted to the orifice (*i*) in the cask (BB) to which it must be cemented: and the length of the pipe from this point must be such as to reach within a few inches of the bottom of the cask (BB) which is to be completely filled with fresh water, or such as has been recovered from lime.

To a quantity of mild calcareous earth and water, as directed in the preceding process, placed in the air vessel (C, fig. 5.) add a small portion of strong vitriolic acid, and by the time most of the common air may be supposed to be expelled by the fixed air, arising from the mild calcareous earth, add a larger quantity of acid, and putting the tubulated stopper (*e*) in its place, the bladder (*f*) will become inflated. Press it gently till its sides collapse; and then introducing the pipe (*bb*) with its cork, into the orifice (*i*) of the cask (BB;) again press the air forward, as it distends the bladder into the water cask, where bubbling up through the water, it will rise to the surface, and by its pressure, force the water to ascend into the
funnel

funnel (*k*) which is to be cemented into the head of the cask at (*l*). In proportion as the water in the cask becomes impregnated with fixed air, that in the funnel will return into its place; but if, at any time, the latter should rise so high as to be in danger of overflowing, a quantity of air may be let out of the water cask, by means of the small plug at (*m*.) And this is necessary to be done, occasionally, to discharge the residuum of the fixed air, which is not soluble in water.

The water may be tasted from time to time, by drawing off a small quantity at a cock fixed into the cask, and when it has obtained a sufficiently pungent taste, the process may be finished. This will take several hours, but in this case little attendance will be requisite.* If the operation be required to be performed more expeditiously, it may be quickened by agitating the water cask. To do this, the tubular stopper (*e*) must be with-

* The operator must be attentive that the top of the cask be air tight. If some water be poured upon it, any defects may be detected by the air bubbling through the water, and the faulty place must be secured with luting.

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drawn from the air vessel, and supported, together with the bladder, by an assistant, while the cask (BB) is shaken. During this time another tubular stopper must be put into the air vessel, and it may be immersed into a quantity of lime-water to prevent waste. When the agitation has been continued for some minutes, in proportion to the falling of the water in the funnel, replace the stopper attached to the bladder (*f*) in the air vessel when taken out of the lime-water, and proceed as before, repeating the agitation occasionally.

During the process, additional quantities of vitriolic acid may be introduced into the air vessel through the opening at (*d*) which is to be, at all other times, carefully secured with its stopper.

Perhaps the most convenient size for the cask, intended for the purpose of impregnating water with fixed air, would be about ten or twelve gallons. Should the scurvy, or other putrid diseases, prevail; or should putrid provisions or other septic causes render

der the crews more than usually liable to such diseases, and occasion a larger consumption of this water to be necessary, the cask may be proportionably larger, or a greater number of small casks may be employed.

I FLATTER myself that I have now pointed out methods, not only of supplying the crews of his Majesty's ships and others, in every climate, with fresh water; but also of affording them a medicinal water, which will not only be a preventative against putrid diseases, but even a powerful remedy when they actually exist.

The expence of precipitating the lime from the water will be very trifling. I imagine that, in performing the process in a large way, eight ounces of mild calcareous earth, and six ounces of strong vitriolic acid will be sufficient for sixty gallons of lime-water. The value of the first is beneath notice, and the present average price of oil of vitriol, at a time that sulphur is very dear, is only five-pence per pound. It is also to be considered, that the whole stock of water will not need

to have lime added to it; that part only which is designed for long keeping will require this treatment.

I would recommend that these operations be performed under the inspection of the surgeons of ships and their mates; they may be conducted with facility; a little practice will make those gentlemen perfect masters of the processes; and, I am persuaded, the liberal spirit which prevails among the professors of the medical art, will not only prevent the rejection of an improvement, merely because it is an innovation, but will incite them to reconcile difficulties, if it be possible they can occur, to promote the practice of what promises so much utility, comfort and salubrity to a body of men, on whom the enjoyment of our liberty, our property, and our religion so eminently depend.

The malt decoction has been found, by experience, to answer in a great degree the beneficial intentions of the late truly amiable, humane and ingenious Dr. Macbride, who first proposed the trial of it. And this salutary
beverage

beverage may have its efficacy still farther improved, by impregnating it, in the above manner, with fixed air. Nay, I even believe that the decoction so impregnated, and inclosed in vessels for a few days, would ferment, and furnish an useful and not unpleasant kind of beer.

I have repeatedly prepared an artificial yeast, by impregnating flour and water with fixed air, with which I have made very good bread, without the assistance of any other ferment. As I apprehend it to be a desideratum to procure fresh fermented bread at sea, at least that it would be an agreeable acquisition to the officers, the process, by which bread has been thus made, shall be subjoined. And if the above application of chemical facts, which were already known; if an improvement and extension of modes which have been already practised, on a less enlarged plan, may, in any degree, tend to the preservation of the health and lives of a part of mankind, more particularly exposed to disease, I shall reflect with pleasure, while my capacity for reflection remains, that I have not lived unprofitably,

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but have contributed my mite to promote the essential interests of my country, and of humanity.

The Process for making artificial Yeast.

BOIL flour and water together to the consistence of treacle. When the mixture is become cold, fill a small cask with it. This cask is to be fitted up in the same manner as that described (BB, fig. 5.) for the impregnation of water with fixed air, and the process is to be conducted in a similar way, except that the cask is to be agitated, as often as the mixture rises to about two thirds of the capacity of the funnel (*k*); and after each agitation, which should continue during several minutes, the unabsoꝛbed air is to be let out, by withdrawing the plug from the orifice (*m*) till that part of the mixture which remained in the funnel have returned into the cask. The orifice at (*i*) should also be larger than is necessary in the former operation, on account of the superior viscosity of the mixture. When, on the agitation being frequently

ly

ly repeated, the mixture, which has ascended into the funnel, does not subside into the cask, it may be supposed to be incapable of absorbing more air.

Pour the mixture, thus saturated, into one, or more, large bottle or narrow-mouthed jar. Cover it over loosely with paper, and upon that a slate or board, with a weight to keep it steady. Place the vessel in a situation where the thermometer will stand from 70 to 80 deg. and stir up the mixture two or three times in twenty-four hours. In about two days, such a degree of fermentation will have taken place, as to give the mixture the appearance of yeast.

With this yeast, when it appears to be in the above described state, and before it have acquired a thoroughly vinous smell, mix the quantity of flour you intend to make into bread, in the proportion of six pounds of flour to a quart of the yeast, and a sufficient portion of warm water. Knead them well together in a proper vessel, and covering it with a cloth, let the dough stand for twelve hours,

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or till it appear to be sufficiently fermented, in a degree of warmth equal to that above-mentioned. It is then to be formed into loaves, and baked.

Perhaps the yeast would be more perfect, if a decoction of malt were used instead of simple water; but of this I have, as yet, had no experience.

The cask in which the yeast has been made, should be well washed as soon as the operation is finished, or it will contract a disagreeable taint.

The Process for making artificial Pyrmont Water.

TO every gallon of spring water add one scruple of magnesia alba, thirty grains of Epsom salt, ten grains of common salt, and a few pieces of iron wire, or iron filings. The operation is then to proceed as in the process for impregnating water with fixed air; and the water, if intended for keeping, must be put into bottles closely corked and sealed.

The

The Process to make artificial Seltzer Water.

ADD one scruple of magnesia alba, six scruples of fossil alkali, and four scruples of common salt to each gallon of water, and saturate the water, as above, with fixed air.

To prepare Mr. Bewley's Julep.

DISSOLVE three drams of fossil alkali in each quart of water, and throw in streams of fixed air, till the alkaline taste be destroyed, and the water have acquired an agreeable pungency. This Julep should not be prepared in too large quantities; and should be kept in bottles very closely corked and sealed. Four ounces of it may be taken at a time, drinking a draught of lemonade, or water acidulated with vinegar, or weak spirit of vitriol, by which means the fixed air will be extricated in the stomach.

REFERENCES TO THE PLATES.

FIG. 1. AA is the cask in which the lime-water is to be purified. It is represented as transparent for the purpose of shewing the situation of the whole apparatus.

(a) Is the moveable top.

(b) The handle.

(c) A small hole to be exactly fitted with a plug.

(dd) The strings by which the air vessel is to be let down.

(ee) Two pegs, placed on opposite sides of the cask, to which the strings are to be fastened before the cask be stopped.

(f) A cock to draw off the water.

Fig. 2. DD. The air vessel, similar to the bottom part of Dr. Nooth's glass machine.

(cc) A glass stopper, ground in to fit the mouth of the vessel, having a number of capillary tubes running from bottom to top in a diverging direction, so as to spread the
air

air in its passage through the water. Perhaps this vessel might be made of pewter instead of glass, but in that case, as the tubes will be larger, a valve would be necessary in the stopper. I apprehend, likewise, that it may be formed of stone-ware; but whatever be the materials, the vessel should be strong, and so heavy as to sink readily in water, by its own weight.

Fig. 3. The stopper viewed separately to shew its capillary tubes.

Fig. 4. A lead weight with an aperture in the middle, to slip over the ring of the handle (*b*) fig. 1.

Fig. 5. BB. A cask whose sides and ends must be perfectly air tight, except two holes to be bored in the top.

C. The air vessel, the same as fig. 2. but having an aperture at (*d*) which is to be fitted with a glass stopper, through which additional quantities of vitriolic acid may be introduced.

(*e*) The perforated stopper, which must have several circular or spiral grooves round its upper

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upper part, to facilitate the fastening of the bladder (*f*) to it, the other end of which must be attached in a similar manner to the broad end of the pipe (*b*) at (*gg.*).

(*b*). A long bent pipe made of pewter, having its lower extremity formed like the larger end of a clifter pipe. The length from the arch to the other extremity must be such as to reach, nearly, to the bottom of the cask BB. This pipe must be cemented into a cork to fit the orifice in the cask at (*i.*)

(*k*) The funnel, with a grooved cork or stopper adapted to it, which is to be inserted and luted into the top of the cask at (*l.*)

(*m*) The small hole, with a plug, to let out the portion of air, from time to time, which is incapable of being absorbed by the water.

Fig. 6. A separate view of the funnel, which may be fabricated of tin, or copper covered with tin.



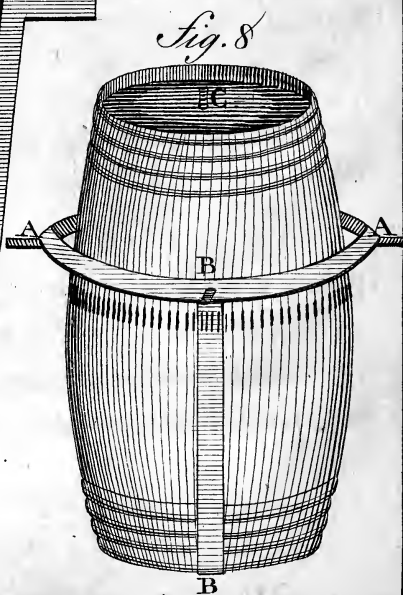
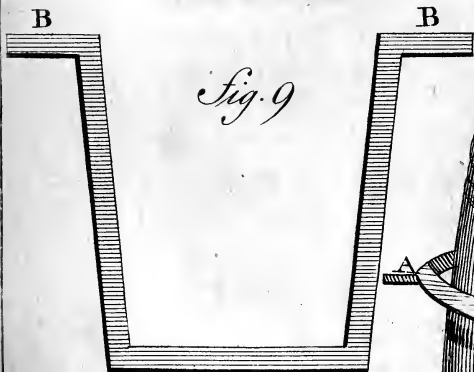
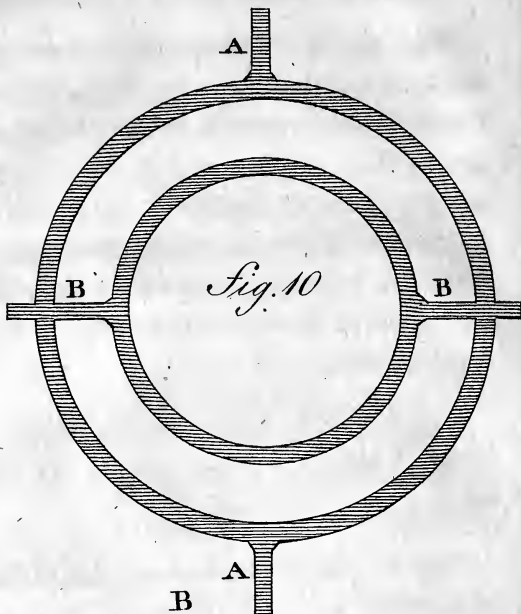
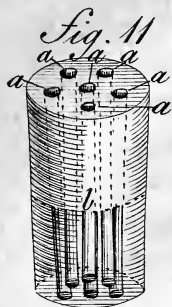


Fig. 7. Is a longitudinal section of an earthen stopper, with a valve and capillary tubes communicating with a larger tube arising from its bottom. I am informed by the glass-makers, that *diverging* capillary tubes are not easily formed in large bodies of glass; and I am induced to think that their diverging is not of so much importance as I at first apprehended.

The following figures are descriptive of the mode of suspending the cask, which will be taken notice of in page 37.

Fig. 8. Is an elevation of the cask, with its gimbols AA—and B, gimbol of the bearing hoop. C the bung—D the bearing hoop passing under the cask.

Fig. 9. The bearing hoop and gimbols BB.

Fig. 10. A plan of the bearing hoop and outer hoop, with the gimbols $\left\{ \begin{array}{c} B B \\ \text{and} \\ A A. \end{array} \right\}$

The scale is an inch to the foot, supposing the cask made use of to be a puncheon.

E

N. B.

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N. B. The gimbols AA, must be inserted into two stanchions under any of the hatchways of the ship, and the insertion must be so high, as to prevent the bottom of the cask from touching the deck below, by the motion of the ship, and these stanchions must stand transversely or athwart ships.

Fig. 11. Is a pewter stopper with compartments *aaaaaa*, into which smaller glass stoppers containing capillary tubes are to be filled, and these are to communicate at *b*, with passages proceeding from the lower surface of the stopper.

P O S T S C R I P T.

AN unavoidable delay, in the publication of the preceding sheets, has afforded me an opportunity of submitting them to the perusal of several gentlemen distinguished for their philosophical knowledge, and to others who to science have had opportunities of adding long experience in maritime affairs. I am happy in having received from many a full, and from all a general approbation of my scheme; and hope it is now in my power to remove the few objections which have been made to it.

My particular acknowledgments are due to Dr. Lind of Haslar hospital, who was so kind to give the pamphlet a candid and attentive perusal. In a letter with which he has been pleased to favour me, he declares his opinion

that the method I have proposed for preserving water, at sea, from putrefaction, *well deserves a public trial*. "I make no doubt," says this ingenious physician, "but very considerable advantages would be derived from it in some situations, but am afraid in others, the agitation of the ship would obstruct the process." This is the only objection which Dr. Lind makes *from himself*; he then proceeds to state such as may perhaps be made by *others*. "With some people also," he observes, "who are accustomed to object to every innovation that is attended with any trouble, and whose principles they do not comprehend, difficulties may be started about the prudence of impregnating all the water with lime, and depending on a process to render it fit for use, which tempestuous weather, the brittle materials of the vessels employed, and even, sometimes, the necessary duties of the ship might interrupt for a length of time. Their prejudices would even urge the time required for purifying the water, and the room taken up by an additional cask or two, had for that purpose upon deck, as objections which, at least, it would
require

require time to remove. I take the liberty to point out the greatest objections that occur to me as being *capable* of being made against its use, that you may have an opportunity of satisfying *others* with respect to them, for with respect to *myself*, I think that all these inconveniences would be more than counter-balanced by having good water at sea, which must materially contribute to the health of the people who drink it."

I with pleasure embrace the opportunity which Dr. Lind has so kindly given me, of satisfying those in whose minds these doubts may have arisen, on perusing the proposed method. On mentioning the Doctor's apprehensions that the process might not be always practicable, in a rough sea, to captain William Robertson, formerly of the marines, a gentleman of great experience, and eminent for his skill in mechanics; actuated by principles of humanity and zeal for the service, he has, very obligingly, furnished me with a mode of suspending the purifying cask in such a manner, that it may always retain its level, whatever be the motion of the ship. A plan, &c.

of the apparatus to be used for this purpose, from a drawing with which captain Robertson has favoured me, will be found in the third plate, to which, and the annexed description, I beg leave to refer the reader for farther information.

By this means the process may be carried on in all weather ; but it is not necessary it should be performed only *immediately when the water is wanted* : The operation may be continually going on, it will require very little attendance, and the water when freed from the lime will keep a considerable time ; much longer, I expect, for reasons, which will soon be adduced, than fresh water from the spring.

Vessels made of stone-ware, of such strength as to make them heavy enough to sink in water, would not be very liable to be broken. If the cautions I have given be properly observed, there will be no danger of explosion, even if the whole quantity of acid be *gradually* added at one time. It would be ingratitude in me to omit professing my obligations
to

to my very worthy and ingenious friend Mr. Wedgwood, for his great and disinterested attention in preparing models of the air vessels, though he candidly acknowledges the vessels may be more advantageously made of what is commonly called stone-ware. But should these be found subject to the inconvenience alluded to, every end will be answered by the use of pewter vessels.* The principal difficulty with respect to the employing of pewter in the fabrication of the air vessels was the supposed impracticability of forming capillary tubes in stoppers of that metal. Fig. 11. exhibits a view of one, in which are several compartments to be fitted with smaller glass stoppers containing capillary tubes; these communicating with other tubes proceeding from the lower surface of the stopper.

A very ingenious correspondent has suggested that inconvenience might arise, from the

* The best London pewter contains but a very small portion of lead, and consists chiefly of tin or bismuth; and as the affinity of vitriolic acid to calcareous earth, so far exceeds its affinity to lead; there can be no danger of any saturnine impregnation to the water.

precipitating lime falling on the stoppers and blocking up the capillary tubes. But it is to be considered, that the constant emission of air through these tubes must prevent this impediment. In all the experiments I have made, such an event has never happened; but should it ever appear that this apprehension is well grounded, a piece of bladder perforated, in several places, with a fine pin or needle, or a double piece of fine linen cloth, tied tightly round the neck of the vessel, allowing the upper part to distend into a convex form, will entirely preserve the tubes from being obstructed. Indeed, from several experiments I have lately made, either of these coverings, when tyed over a perforated cork, or pewter stopper, or even over the mouth of the air vessel without either cork or stopper, will serve as a substitute for capillary tubes: and thus the danger of the process being impeded by accidents to the apparatus is almost annihilated; for any large bottle, weighted so as to sink in water, which may be done by a sufficient quantity of pebbles, and tyed over in the above method, may be employed as an air vessel for the precipitation of the lime.

I have

I have never been at sea; but so little attendance does the process require that I cannot conceive it will ever interfere with the necessary duties of the ship. In the distillation of sea water the constant attendance of at least two men is required.—In the operation of precipitating the lime from the water, when the air vessel is immersed, the process goes on of itself and during the whole time will scarcely require fifteen minutes attendance. These observations will also obviate the objection respecting the length of time required for the operation. I believe I have in the preceding account extended it to the utmost; but in a process which is almost, self-conducted, and continually going on, this objection can have no weight. As to the room taken up by the additional casks, captain Robertson assures me they may be conveniently disposed of under the hatchways and removed occasionally without any impediment to the business of the ship. But if the advantage of being supplied with sweet instead of putrid water, be not superior to every trifling inconvenience that may be urged, it is not worthy the research.

I trust

I trust I have now answered every objection that can be made against my proposals. One circumstance has appeared since the printing of the former part of this account, which was entirely unexpected, but must prove an additional recommendation of the method. Water is not only preserved from putrefaction, but meliorated from its original qualities by the operation, which has much the same effect, in some instances, as distillation upon it; with this advantage, that the water is not deprived of its air by the process, as it is when distilled. Very hard water, from different pumps, having been impregnated with quick-lime, and afterwards freed from it by means of fixed air, was rendered soft as rain-water, afforded little or no precipitation when a solution of fixed alkali was added to it, and united readily and perfectly with soap: whereas, previous to the operation, it deposited a very large sediment on the addition of fixed alkali, and formed turpeth mineral on dropping in a small quantity of a solution of quick-silver in nitrous acid. But, notwithstanding these proofs that the water contained a vitriolic salt, it must remain to be determined, by farther

ther experiments, whether the water, used in these trials, owed its hardness, *principally*, to such a salt, or, like the Rathbone-place water, to calcareous earth dissolved in it by means of fixed air. Lime-water mixed with it, in equal proportions, became turbid, and, when the precipitate had subsided, the water was softened.

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